7.0 DETERMINATION OF BACKGROUND CONCENTRATIONS FOR INDICATOR CONTAMINANTS

Contaminant concentrations at a CERCLA site may be due to releases from the site itself, as well as natural and/or anthropogenic sources that are not site-related. Thus, site-specific background concentrations are needed as a means to distinguish site-related contamination from non-site-related chemical contamination, as well as for developing remedial goals and for characterizing risk from contaminants that may also be attributed to background sources. USEPA policy (USEPA 2002b) provides the framework by which background concentrations should be considered at CERCLA sites.

An understanding of background conditions is important in the case of Portland Harbor because of the urbanized and industrialized setting of the region, and the fact that the lower portion of the river is influenced by many human activities occurring upstream throughout the broader watershed. This section describes the identification of the relevant background sediment data set for the RI/FS, discusses the evaluation of those data for use in the RI/FS, presents a statistical analysis, and provides the complete, final RI background data sets in an electronic format.

The approach used to determine background sediment concentrations reported here is documented in a series of RI technical memoranda and associated USEPA comment letters (Kennedy/Jenks, Anchor, Integral, and Windward 2006; USEPA 2006m; USEPA 2008c,d; LWG 2008a,b; USEPA 2013a).

The discussion presented in this section is organized as follows:

- Section 7.1 presents definitions based on USEPA guidance that are relevant to the determination of background in the RI.
- Section 7.2 describes the process that was employed to generate appropriate data sets for characterizing background concentrations in surface sediments, including identification of chemicals for which background estimates are needed, selection of reference area, establishment of data quality requirements, and evaluation of data.
- Section 7.3 presents the background analysis for surface sediments including outlier identification and development of estimates of CT and background threshold values (BTVs) estimates using ProUCL.

7.1 DEFINITIONS AND USES OF BACKGROUND IN THE RI/FS PROCESS

The following USEPA documents were reviewed to assist in providing a consistent set of definitions, as well as recommended uses, of background data in the Portland Harbor RI/FS:

- *Role of Background in the CERCLA Cleanup Program* (USEPA 2002b)

- *Guidance for Comparing Background and Chemical Concentrations in Soil for CERCLA Sites* (USEPA 2002c)
- *Determination of Background Concentrations of Inorganics in Soils and Sediments at Hazardous Waste Sites* (USEPA 1995b)
- *ProUCL Version 5.0 Technical Guide* (USEPA 2013b).

The following definition provided in USEPA (2002b) was adopted for the Portland Harbor RI/FS:

- **Background**—Substances present in the environment that are not influenced by releases from a site and are usually described as naturally occurring or anthropogenic.
  1. ***Naturally occurring*** – substances present in the environment in forms that have not been influenced by human activity; and,
  2. ***Anthropogenic* –** natural and human-made substances present in the environment as a result of human activities (not specifically related to the CERCLA release in question).

The term "reference area" is defined here as where background samples were collected for comparison with samples collected on-site. The reference area should have the same physical, chemical, geological, and biological characteristics as the site being investigated, but should not have been affected by activities on the site. Background reference areas are normally selected from off-site areas, but are not limited to natural areas undisturbed by human activities.

7.2 BACKGROUND DATA SET IDENTIFICATION

Identification of an appropriate background data set is a critical element of a CERCLA background evaluation and involves the overlapping considerations of which contaminants are relevant for background determination, the selection of a suitable reference area(s), and the data quality requirements. These elements are discussed in Sections 7.2.1 through 7.2.4. Data management and evaluation is discussed in Section 7.2.5. Identification and treatment of outlying data points that may reflect the influence of point sources of contamination or may not be representative of the dominant background population is addressed in Section 7.3. Appendix H contains the background data set in electronic format and outputs from ProUCL 5.0 for the indicator contaminants.

7.2.1 Contaminants Considered in the Background Analysis

The selection of indicator contaminants for which background was established is based primarily on the contaminants of concern identified in the BHHRA and BERA. These include naturally occurring chemicals (primarily metals) as well as man-made chemicals whose use and environmental persistence has resulted in a widespread, anthropogenic background concentration unrelated to specific Portland Harbor sources. The determination of indicator contaminants is discussed further in Section 5.

For the RI, background concentrations were either established or attempted for the following indicator contaminants:

- Aldrin
- Arsenic
- BEHP
- Total chlordanes
- Chromium
- Copper
- Total DDx
- Dieldrin
- Mercury
- Total PAHs
- Total PCBs as Aroclors
- Total PCBs as congeners
- Total PCDD/Fs
- TBT
- Zinc.

Background concentrations were also either established or attempted for an additional 19 contaminants, and those results are presented in Appendix H.

Commented [RC1]: Although the determination of indicator contaminants was discussed in Section 5, it would be worth noting here why these 19 additional concentrations were established. Currently, it is unclear how these are different, if they are different, from the indicator contaminants listed above.

We suggest elaborating on the reason for developing background on the additional 19 contaminants. .

7.2.2 Reference Area Selection

In consultation with USEPA, DEQ, and the Tribes, the Upriver Reach of the lower Willamette River extending from RM 15.3 to 28.4 was selected as the reference area for determining background sediment concentrations (Maps 7.2-1a–b). This area, which extends from the upstream end of Ross Island (just upstream of the downtown Portland area) to approximately 2.5 miles above Willamette Falls, was chosen because it is considered broadly representative of the upstream sediment loading to Portland Harbor. Although much of the upriver reach is characterized by an exposed natural bedrock bottom and swifter currents than generally found in the Study Area, there are pockets of reworked sand and finer-grained sediments along the margins and in backwaters. The area is representative of the urban and suburban upland conditions along the banks of the lower Willamette River as it flows into Portland through its suburbs, but is upstream and uninfluenced by releases from the Portland Harbor Site. Because of the urbanized and developed setting, the reference area may be influenced by historical or current local point sources such as shoreline industrial facilities and overwater structures, as well as non-point sources.

7.2.3 Data Quality Requirements

Contaminant concentrations in sediment in the reference area have been the subject of both LWG and non-LWG characterization efforts. Because an accurate background data set is of importance to project stakeholders, only those data meeting the stringent Category 1, QA Level 2 data quality requirements established for the baseline risk assessments were considered for inclusion in the background data set.

Data that meet these criteria for surface sediments in the reference area are available from the following investigations:

- LWG Round 2A Sediment Sampling, 2004
- LWG Round 3B Sediment Sampling, 2007
- 2005 Portland District O&M Sediment Characterization
- Corps Dredged Materials O&M Sediment Characterization, 2004
- McCormick & Baxter RI Phase 3, 1999
- USEPA Blue Heron & West Linn Paper Mill Site Investigations, 2007.

Individual sample locations from these investigations and within the reference area are shown on Maps 7.2-1a–b.

Samples from the USEPA 2007 investigation were analyzed using Method SOM01.2, and comprise the bulk of the available sampling conducted upstream of RM 23.2. The results for Arcolors, aldrin, chlordane, dieldrin, and DDx compounds were consistently non-detect. An initial conclusion from these results would be that the potential for recontamination by ambient organochlorine compounds from this reach of the river is nonexistent. However, samples from these locations also analyzed for PCBs as congeners display a consistent pattern of detections. The Method SOM01.2 data were further reviewed with respect to the results for persistent organochlorine compounds, and the results for aldrin, Aroclors, chlordane, and dieldrin consistently display a pattern of high detection limits relative to the detection limits reported for these analytes in other reference area investigations. For this reason, data for Aroclors, aldrin, chlordane, dieldrin, and DDx obtained by Method SOM01.2 were excluded from the calculation of background. The results for all other indicator contaminants appear generally consistent with the results from other investigations, and these data were retained in the background calculations.

Appendix D1.4 presents an analysis of the comparability of PCB Aroclor data analyzed by Method SW8082 to congener data analyzed using Method 1668A. This analysis concluded that the data are "fairly comparable between methods in most cases."

Commented [RC2]: If this is a direct quote from an analysis then we suggest adding the relevant citation.

However, their comparability is less certain at the lower concentrations associated with the regional anthropogenic contribution. A total of 33 samples in the background reference area were analyzed for both PCBs as Aroclors and congeners. Although there are several exceptions, the Aroclor results are generally greater than the corresponding congener data, often by a factor of ~~2~~ two or more. The calculated correlation between these two data sets is presented on Figure 7.2-1, and a scatter plot of these results by river mile is presented on Figure 7.2-2. Because the two data sets are not well correlated in the concentration range associated for this background analysis, they were not combined into a single PCB data set, and separate background statistics were calculated for PCBs measured as Aroclors and as congeners.

Commented [RC3]: Numbering convention in writing is such that numbers less than 10 should be spelled out if they are not reporting scientific measurements. We have noticed throughout the sections and their tables that this convention is alternately followed and not followed. We suggest being consistent across sections.

I have edited this first instance as an example, but have not edited subsequent instances.

7.2.4 Measurement Basis for Surface Sediment Background Estimates

Background values for surface sediment were estimated on a dry weight basis. Dry-weight background values were adjusted to reflect the differences between the mean organic carbon content of surface sediments in the reference area and the Study Area. These estimates, termed OC-equivalent dry-weight values, were calculated as follows:

$$C_{dw,eq} = C_{dw,bgrnd} \times \frac{TOC_{SA}}{TOC_{bgrnd}}$$

Where,

$C_{dw,eq}$ = OC-equivalent dry-weight sediment concentration
$C_{dw,\,bgrnd}$ = Dry-weight background sediment concentration
TOC_{SA} = Study Area surface sediment mean TOC (1.71%)[1]
TOC_{bgrnd} = Background surface sediment mean TOC (1.11%).

7.2.5 Data Management and Evaluation

The background data sets were evaluated to address field replicates, remove high-biasing non-detect results, and incorporate non-detect values in the calculation of results presented as totals.

Field replicates reported in the sediment data set were averaged to provide a single reported value to avoid introducing spatial bias into the data set by “double-counting” replicates from the same station.

Consistent with USEPA guidance (USEPA 1989) and USEPA comments on the Round 2 Report (USEPA 2008b), non-detect results with a reporting limit higher than

[1] This Study Area average surface sediment TOC is based on the RI data set compiled through June 2008 for the 2009 Draft RI report. The Study Area average TOC surface sediment for all data compiled through July 2010 for this Final RI report is 1.79%.

the highest detected result for a given analyte in the surface sediment background data set were flagged as high-biasing non-detects and were excluded.

Chemical concentrations for multiple-constituent analytical totals were calculated using the rules established for the baseline risk assessments. Specifically, detected values were included at their reported concentrations, and non-detects were included at one-half of the reporting limit for those analytes that were detected at least once in the background data set. Chemicals that were never detected in a given background data set were excluded from the analytical totals. Finally, if all analytes contributing to a sum were not detected in a given sample, then the highest reporting limit for any of the individual analytes within the given sample was reported for the total and qualified with a non-detect flag (U-qualified).

7.3 SURFACE SEDIMENT BACKGROUND OUTLIER DISPOSITION AND STATISTICAL ANALYSIS

A key element of developing appropriate background is to ensure that the data set is as free as possible of data points that are not representative of the background conditions. While it is important to obtain samples from a reference area that has not been influenced by releases from the site or other known point sources of contamination, in practice, natural background conditions may no longer exist and cannot be known with certainty. As a result, the reference area data may also contain high-biasing outliers that are either not representative of the dominant background population or are representative of specific contaminant sources. USEPA guidance (USEPA 2013b) notes that when present, the presence of a few high outliers can mask the normality of a data set, and that a lognormal distribution tends to accommodate outliers. Additionally, the presence of outliers tends to distort decision statistics of interest such as upper prediction limits (UPLs). While the actual origin of high-biasing outliers is not always clear, USEPA recommends that to provide a proper balance between false positives and false negatives, methods to calculate upper limits to describe background should only be used when the background data set represents a single environmental population without outliers, and that "*upper limits computed by including a few low probability high outliers tend to represent locations with those elevated concentrations rather than representing the main dominant background population*" (emphasis in original). Thus, BTVs should be estimated by statistics representing the dominant background population represented by the majority of the data set.

To assess the influence of outliers on the various statistics of interest, USEPA guidance (USEPA 2013b) recommends calculating all relevant statistics using data sets both with and without outliers. This step provides for a direct comparison of the influence of outliers on the various statistics of interest, such as the mean and UPL, needed to inform the decision on the disposition of specific outliers. Table 7.3-1 presents the calculated values of the upper threshold and CT statistics for background sediments on a dry weight basis for two cases—with potential outliers included (all data), and with the identified potential outliers removed. The table also includes the OC-equivalent concentrations for the same statistics based on the OC-correction factor described

Commented [RC4]: A citation should be provided for this quote. It is likely USEPA 2013b (cited above this line), but this citation should also be provided immediately after the quote.

Commented [RC5]: This table also does not follow numbering convention in writing. Additionally, there are some spelling mistakes ("approximate" instead of "approximately"). We suggest editing the text in this table.

above. An analogous table containing background statistics on a dry weight and OC-equivalent basis for an additional 19 sediment contaminants is provided in Appendix H.

Classical statistical tests were used to in conjunction with visual and graphical evaluations to aid in identifying potential outliers. The statistical evaluation utilized the either Dixon's or Rosner's tests, depending on the size of the specific data set. Dixon's Extreme Value test is used to test for outliers when the sample size is 25 values or less. The test is capable of determining whether individual values represent outliers at a specified significance. Rosner's test can be used to identify up to k=10 outliers in data sets of 25 or greater. The details of these tests are described in USEPA (2013b).

Although it is not necessary for the data to be normally distributed to apply either Dixon's or Rosner's test, the resulting data after the potential outliers are removed should follow a normal distribution (USEPA 2013b). However, this condition was not met in all instances, and thus greater emphasis was given to the visual examination of the data to supplant the results of the statistical tests alone. Because the intent here is to identify outliers at the right tail of the data distribution, treatment of non-detect results in outlier identification is less critical than when calculating descriptive statistical moments. Hence, non-detect values may be replaced by their respective detection limits, one-half the detection limit (DL/2), or ignored altogether. For these evaluations, non-detects were included at one-half the detection limit. Graphical review of the data was conducted using box-whisker plots, normal Q-Q plots with non-detects set at the reporting limit, and river mile concentration plots shown in Figures 7.3-1 through 7.3-15. Appendix H includes analogous figures for the additional sediment contaminants.

Estimates of CT (the 95 percent upper confidence limit [UCL] on the arithmetic mean, or 95 UCL) and an upper limit, defined as the 95 percent upper prediction limit (95 UPL) were generated using ProUCL Version 5.0. The 95 UPL represents a statistic such that an independently collected new observation from the same population will be less than or equal to the UPL with a confidence coefficient of 0.95.

The data analysis for each of the indicator contaminants is described in the following subsections. Outliers that were not considered representative of background were excluded from the calculation of background as described below.

7.3.1 Aldrin

No background value was calculated because the detection frequency was only 12.5 percent, even after excluding the Method SOM01.2 data. Background for aldrin is considered to be the method detection limit.

7.3.2 Arsenic

Three samples were identified as potential outliers in both the graphical data evaluation and Rosner's test: U6TOC-2, U6TOC-2, and WR085D. After excluding these potential outliers, the remaining data follow a normal distribution.

Commented [RC6]: Table 7.3-1 states that the distribution is "approximately normal". Stating "approximately normal" here would be more consistent with the table and more accurate overall.

Other contaminants in this section (specifically in the subsections following this one) that reportedly have a "normal" distribution are also actually "approximately normal". We suggest editing the text to include this distinction.

7.3.3 Bis(2-ethylhexyl) phthalate

Four samples were identified as potential outliers in both the graphical data evaluation and Rosner's test: U1C-3, UG11C, UG03B, and UG03C. Because the highest detected result is an order of magnitude greater than any other detection, it tended to mask the presence of the other potential outliers. Thus, the data were examined visually without the result at U1C-3 to confirm the conclusion from Rosner's test. Although the resulting data set without these samples did not meet the condition of following a normal distribution, these results appear sufficiently distinct from the remaining dominant population to warrant their exclusion from the background calculation.

7.3.4 Total Chlordanes

Only U6TOC-2 was identified as a potential outlier. The resulting data follow a normal distribution.

7.3.5 Chromium

No potential outliers were identified and the full background data set follows a normal distribution.

7.3.6 Copper

No potential outliers were identified and the full background data set follows a normal distribution.

7.3.7 Total DDx

Two samples were identified as potential outliers in both the graphical data evaluation and Rosner's test: U12GA and U6TOC-2. The data followed a normal distribution both prior to and after removal of the potential outliers. However, visual examination of the data indicates that the two potential outliers appear sufficiently distinct from the remaining dominant population to warrant their exclusion from the background calculation.

7.3.8 Dieldrin

No background value was calculated because the detection frequency was only 5 percent, even after excluding the Method SOM01.2 data. Background for dieldrin is considered to be the method detection limit.

Commented [RC7]: There appears to be a discrepancy between what is reported in Table 7.3-1 and what is described here. For instance, Total DDx is listed as having no background calculated, while dieldrin does appear to have background calculated. Please correct the text and/or table accordingly.

7.3.9 Mercury

No potential outliers were identified and the full background data set follows a normal distribution.

7.3.10 Total PAHs

Three samples were identified as potential outliers in both the graphical data evaluation and Rosner's test: UGO4B, SED099-42, and UG12C. After excluding these potential outliers, the data follow a normal distribution.

7.3.11 Total PCBs as Aroclors

As discussed in Section 7.2.3, data analyzed as Aroclors by Method SOM01.2 were removed from the background data. A review of the graphical data evaluation indicated four values that appeared to clearly represent outliers. Rosner's test identified a total of five samples as potential outliers: UG02C, U2C2, UG03C, UG03B, and UG02A. The data do not follow a normal distribution after elimination of the potential outliers. However, they are all located between RM 16 and 17, and appear sufficiently distinct from the remaining dominant population to warrant their exclusion from the background calculation.

7.3.12 Total PCBs as Congeners

Four samples were identified as potential outliers in both the graphical data evaluation and Rosner's test: WR08SD, U2C-2, WR04SD, and TR01SD. Although the resulting data set without these samples did not meet the condition of following a normal distribution, these results appear clearly distinct from the remaining dominant population to warrant their exclusion from the background calculation.

7.3.13 Total PCDDFs

Only U1C1 was identified as a potential outlier. Although the condition of following a normal distribution was not met after excluding this result, this value appears clearly distinct from the remaining dominant population in the graphical data evaluation.

7.3.14 Tributyltin Ion

Only three samples were collected and analyzed for TBT in the upstream data set; this is not sufficient data to establish a background concentration.

7.3.15 Zinc

A single potential outlier (U2C-2) was identified. The data follow a normal distribution both with and without the potential outlier. While this result appears sufficiently distinct from the rest of the data, the resulting calculated BTV and UCL are similar with and without incorporating this potential outlier.